REMARKS

In response to the Office Action mailed August 16, 2005, Applicants respectfully request reconsideration.

Claims 27-36 are cancelled; claim 37 has been amended; claims 38-40 are added. Claims 1-26 and 37-40 are pending, of which claims 1, 14 and 40 are independent claims.

Claims 20, 21, 24 and 26 have been objected to as being dependent on a rejected base claim, but were deemed allowable if rewritten in independent form to include all of the limitations of the base claim and any intervening claims. This action has not been taken, because it is believed that the base claim 14 is also allowable over the cited references as discussed below. Applicant reserves the right to amend these claims to place them in allowable form at such later time as the allowability of claim 14 has been decided.

A revised Figure 1 is submitted herewith to correct one instance of the reference number 132 to 132'. Also, paragraph [0038] has been amended to correct the reference numbers for consistency with Figure 2.

Rejections under §103

Claims 1, 7, 14-16, 28, 29, 35 and 36 have been rejected under 35 U.S.C. § 103 as being obvious in view of Bamji (US 6,580,496) and Sapia (6,166,853). This rejection is now moot with respect to cancelled claims 28, 29, 35 and 36. With respect to the remaining claims, this rejection is respectfully traversed.

In order to establish a *prima facie* case of obviousness, the Office Action must meet three criteria.

> "First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations."

In re Vaeck, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

It is respectfully submitted that the Office Action fails to establish a prima facie case of obviousness because the combination of Bamji and Sapia do not teach or suggest all the features recited in the rejected claims.

Claim 1 recites a system for three-dimensional imaging including the following elements:

> receiving means operable to receive a portion of a first output of a light source reflected from a target through atmospheric turbulence;
>
> a first image sensor operable to produce two or more two-dimensional image slices of the target;
>
> a second image sensor operable to detect two or more second sensor images of the target;
>
> means for multiframe blind deconvolution operable to determine a point spread function from the two or more second sensor images;
>
> means for deconvolution operable to deconvolve the point spread function from the two or more two-dimensional image slices and to produce two or more deblurred two-dimensional image slices; and
>
> means for combining the deblurred two-dimensional image slices operable to form a three-dimensional image of the target.

One important aspect of the system of claim 1 is its use of two sets of sensor images. A first set of image slices of the target is provided to the deconvolution means that deconvolves the point spread function from the first set of image slices to produce two or more de-blurred image slices. The second set of images is provided to the multiframe blind deconvolution means in order to determine the point spread function that is provided to the deconvolution means. In other words, the point spread function is itself determined from sensor images of the target. It is further noted that the image sensors are operating on light

reflected from the target through atmospheric turbulence, which is dynamic in nature. Thus, it will be appreciated that the actual point spread function of the overall system is in general constantly changing as the atmospheric turbulence conditions change. By operating on the images of the target received through the same atmospheric turbulence that contributes to the image blurring in the first place, the multiframe blind deconvolution means generates a point spread function that accurately represents the actual point spreading that occurs in the system, even as conditions constantly change, and thus the resolution improvement is maintained notwithstanding the changing conditions of atmospheric turbulence.

Bamji discloses a system for measuring distance and brightness of an object that includes illuminating the object with optical energy and receiving reflected optical energy at an array of photodetectors 240. Each photodetector 240 has associated circuitry 250 that modulates the "quantum efficiency" of the photodetector in a manner such that the output of the circuitry represents a phase magnitude that can be converted into a distance value. Contrary to the assertion in the Office Action, Bamji does not show (in Figure 4 or elsewhere) a system having first and second image sensors that detect respective two-dimensional images of the target object. Figure 4 of Bamji simply shows two pixels of a single 2-dimensional array of pixels. The output of a single circuit 250 of Figure 4 of Bamji is not a 2-dimensional image, but simply a single scalar phase value at one pixel location (i.e., a zero-dimensional point value). Bamji clearly shows only one 2-dimensional image sensor (e.g. array 230 of Figure 3), of which Figure 4 shows only two individual pixels.

Additionally, Bamji shows an overall system that can be used for rangefinding for example - Bamji is not concerned with the problem of blurring caused by atmospheric turbulence. The system of Bamji includes a detector array 230 made up of individual pixels such as shown in Figure 4, as well as processing elements 260, 270 and 280 that operate on the phase signals generated by the array 230. Bamji does not describe any particular processing

carried out by the elements 260, 270 and 280 on the overall 2-dimensional phase data generated by the array 230. There is no description of any de-blurring or deconvolution, nor any mention of using separate sets of two-dimensional images for deconvolution and determination of the point spread function as described above.

Sapia shows a technique for three-dimensional deconvolution of optical microscope images which operates in two modes. In the normal operation mode, source image data is provided to a fixed deconvolution filter that serves to deconvolve a predetermined point spread function from the source image to generate a corrected image. The other operation mode is an initial mode in which the weights for the deconvolution filter are calculated. This operating mode employs an actual point source such as a fluorescent micro-sphere having an a-priori known image. The actual image data is supplied to the deconvolution filter, and the output of the filter is compared with the known image to generate an error value. The error value is used to calculate adjusted weights for the deconvolution filter. This process occurs iteratively until the error value is minimized.

Based on the above understanding of Sapia, it should be clear that Sapia does not show multiframe blind deconvolution. In the normal operating mode, the deconvolution is predetermined based on the fixed weights provided to the filter. In the initial mode, the deconvolution is adjusted based on comparing the actual image data with expected (known) image data, which of course is quite contrary to blind deconvolution which by definition knows little or nothing about the image data on which it operates.

Moreover, in both modes of operation of Sapia, the light from the target (whether an unknown item or the known point source) is supplied only to the deconvolution filter. Thus, there is only one set of 2-dimensional image data, that supplied to the deconvolution filter. There is no separate set of 2-dimensional images generated in Sapia, and indeed none is necessary. Sapia performs two serial operations using one 2-dimensional image input, which in one operation

represents a known point source and in the other operation represents an unknown target object.

Furthermore, it will be appreciated that if the point spread function of the system of Sapia were to change during operation, the quality of the deconvolution would presumably deteriorate because it is based on the point spread function as existing during the initial operation of calculating the filter weights. Thus Sapia, like Bamji, does not address the problem of achieving quality de-blurred images in the presence of atmospheric turbulence, which by its dynamic nature would limit the effectiveness of the static deconvolution employed in Sapia.

It is respectfully urged that the combination of Bamji and Sapia cannot render claim 1 obvious, because neither of these references teaches or suggests all the elements thereof. In particular, neither of these references teaches or suggests the use of blind deconvolution, nor the use of two image sensors generating two sets of two-dimensional images, one used for multiframe blind deconvolution to determine a point spread function, and the other used for the deconvolution operation by which the point spread function is deconvolved from the two-dimensional image slices to produce two or more deblurred two-dimensional image slices. As noted above, Bamji teaches only a single two-dimensional detector array and does not provide any teaching with respect to the overall image processing performed on the array data, specifically nothing regarding any blind deconvolution. Sapia also teaches the use of only one two-dimensional image from a target object, once during a fixed deconvolution operation and once during an iterative process of fixing the weights of the deconvolution filter by minimizing an error value between an actual deconvolved image and a known image. Because these features of claim 1 are entirely absent from both Bamji and Sapia, it is respectfully urged that these references cannot render claim 1 obvious under 35 U.S.C. § 103,

Based on the foregoing, claim 1 is seen to be allowable in view of the combination of Bamji and Sapia. Favorable action is respectfully requested.

The remaining claims incorporate, either directly or indirectly, features like those discussed above with respect to claim 1, and therefore the remaining claims are seen to be allowable for at least the reasons given above.

Newly Added Claims

Claims 38-40 have been added and are believed to be in allowable condition. Claim 40 is a new independent system claim written without the use of means clauses. Claims 38 and 39 depend from claims 1 and 14 respectively, and set forth two specific features that further distinguish the Bamji and Sapia references. The first and second image sensors are specified to be respective plane arrays of photodetectors, and thus clearly do not read on single photodetectors that constitute pixels of one photodetector array. Also, a beam splitter is used to direct respective first and second portions of collected light output from the receiver to the first and second image sensors. Both of these features are seen to be absent from Bamji and Sapia. Support for these claims can be found in Figure 1 and the related text, including paragraphs 23 and 26. No new matter has been added.

Conclusion

In view of the foregoing remarks, this Application should be in condition for allowance. A Notice to this affect is respectfully requested. If the Examiner believes, after this Response, that the Application is not in condition for allowance, the Examiner is respectfully requested to call the Applicants' Representative at the number below.

Applicants hereby petition for any extension of time which is required to maintain the pendency of this case. If there is a fee occasioned by this response, including an extension fee, that is not covered by an enclosed check, please charge any deficiency to Deposit Account No. 50-0901.

If the enclosed papers or fees are considered incomplete, the Patent Office is respectfully requested to contact the undersigned collect at (508) 366-9600, in Westborough, Massachusetts.

Respectfully submitted,

James F. Thompson

James F. Thompson
Attorney for Applicant(s)
Registration No.: 36,699
CHAPIN & HUANG, L.L.C.
Westborough Office Park
1700 West Park Drive
Westborough, Massachusetts 01581
Telephone: (508) 366-9600
Facsimile: (508) 616-9805

Attorney Docket No.: TXT05-05

Dated: November 16, 2005

IN THE DRAWING

Please replace sheet 1 of the drawing with a revised sheet 1 enclosed herewith. The only revision is to correct one instance of the reference number 132 to 132' (left side of the Figure).